the neighbourhood of the gut, and which later on, becoming connected with the gut, laid the foundation of an important organ, the cœcum.

Excretory Organs, p. 437.—The author favours Boveri's hypothesis of the evolution of the archinephric duct, but with an almost fundamental modification. However, this explanation, being inapplicable to Cyclostomes, leads to new difficulties and further doubts, which partly undo what has been elaborated just previously. H. GADOW.

THE WORK OF MARIGNAC.

Œuvres complètes de J. C. Galissard de Marignac. Tome ii., 1860–1887. Pp. 839. (Paris: Masson and Co., n.d.)

IT is by no means an easy task to give an intelligible account of the labours of such an industrious and versatile worker as Marignac was. An outline of his life, written by M. Ador, his son-in-law, who edits the two large volumes of his republished work, has already been noticed in these columns. It now remains to deal with his researches, of which only a sketch has previously been given.

The three main lines of investigation treat of (1) the rare metals of their compounds, (2) crystallographic measurements, and (3) thermal chemistry. Under the first heading, we find memoirs on beryllium, lanthanum, didymium, yttrium, erbium, niobium, tantalum, "ilmenium," zirconium, mosandrum, and ytterbium, the last a discovery of his own. The final article in the book, published in 1887, is a criticism of Sir William Crookes's paper "On the Genesis of the Elements"; Marignac is not disposed to accept the interpretation which Crookes places on the different spectra of successive fractions of "yttrium," viz., that a gradual separation of an element into parts endowed with different properties has taken place; he rather inclines to attribute the varying spectra to the accumulation at each end of fractions of impurities, each of which has the power of profoundly influencing the spectrum of the real yttrium.

The equivalents of no fewer than twenty-eight elements were determined by Marignac; and at the end of the book a comparison is made between the values found by him and the table of the International Committee of 1903. The correspondence between the two is very striking; indeed, in no fewer than fourteen instances, the numbers are almost identical. It is strange, however, that Stas found for the atomic weight of iodine the number 126.85, while Marignac agrees more nearly with later determinations by Ladenburg and by Scott. In stating his results, Marignac is always modest. He writes:—

"Je puis bien reconnaître, après avoir étudié le beau travail de ce savant, qu'il a apporté, dans ses expériences, des soins infiniment plus minutieux que ceux que j'avais cru devoir prendre."

Nevertheless, in almost all cases, the agreement with Stas is a very close one. He is by no means convinced that Prout's hypothesis is put out of court by Stas's researches; he draws attention to the fact that while the mean variation from whole numbers of the atomic weights determined by Stas should be about 0.5, it is only 0.103, even if chlorine be included; and if chlorine be rejected, it is reduced to 0.068.

From time to time, Marignac wrote criticisms of notable papers recently published; and in many instances he repeated the work of the authors. His remarks were always gentle and kindly, hence he never was drawn into controversy. Yet he bore his share in attempting to solve the questions of his day; he published many papers relating to dissociation; the most noticeable deals with the specific heats of gaseous ammonium chloride, mercuric chloride, and sulphuric acid, and the heats of volatilisation of these bodies. The latter are naturally high, for they include the heat of dissociation. Marignac's criticisms are, however, sometimes a little naïve; for example, after drawing attention to Andrews's and Tait's observation that the volume of ozonised oxygen is increased permanently by raising its temperature to 230°, he remarks:—

"Or, une condensation aussi considérable que celle qui résulterait des expériences de MM. Andrews et Tait eut été un fait trop saillant et trop important pour échapper à ces habiles chimistes (MM. Fremy et Becquerel) ou qu'ils n'en fissent pas mention."

If this species of argument were permitted, the progress of science would be slow.

Marignac's crystallographic measurements are very numerous, and were evidently made with the greatest care; they should form a valuable storehouse of facts, when our knowledge of the relation between the forms of matter and its constitution has been further developed.

Among his researches on thermal chemistry, besides those relating to anomalous vapour-densities, Marignac devoted much time to the investigation of the specific heats, densities, and expansion of solutions. Like all his work, it is careful and exact, but led to no important conclusions.

Enough has been said to give the reader an idea of the enormous productivity of Marignac. In his own field, that of the rare earths, he is probably unsurpassed as an investigator, and in issuing this collection of his memoirs, M. Ador has erected to him a monument "aere perennius." W. R.

IRRIGATION IN THE WESTERN STATES OF AMERICA.

Irrigation Institutions. A Discussion of the Economic and Legal Questions created by the Growth of Irrigated Agriculture in the West. By Elwood Mead, C.E. Pp. xi+392. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 5*s.* net.

THIS work was originally prepared for a course of lectures on the institutions and practice of irrigation for the University of California. The author is of opinion that the land in the United States that has hitherto been relied on to meet the demands of the nation's growth will not much longer be available for this purpose, so rapid has been the increase

population during the last few years. It is anticipated that at the end of the next half century there will be 200 million people to feed. It has for some time past been recognised that the arid regions of the West, at the foot of the Rocky Mountains, consisting of enormous areas of barren sands broken only by patches of yuccas and sage bushes, becomes, if irrigated, capable of growing crops of all kinds and in the greatest luxuriance. Already where irrigation has been applied, the traveller almost suddenly passes from a desolate and an apparently worthless region to a land of plenty, and is confronted by orchards and gardens which resemble the century old creations of France and Italy, with homes rivalling in taste and convenience those of the eastern States. The climate, though arid, is remarkably healthy, the heat of the southern summers and the cold of the northern winters being mitigated by the dryness of the atmosphere. The mountains and valleys of this district are recognised as natural sanitaria, to which thousands of persons resort in order to live. The arid land, when irrigated, is capable of producing crops worth 20*l.* an acre. Oranges and grapes grow and ripen abundantly, and in Southern California an orange grove of twenty acres constitutes an estate.

The value of the land for raising crops when irrigated became first recognised by the flourishing condition of the colony established by Horace Greely in Colorado, and after his success numerous irrigation schemes were set on foot, both by single settlers and companies. The first step in the change from sage bush desert to fields of grain is the construction of a ditch by the small holder, or of a canal which shall be large enough to water several farms. These canals, in some cases, are large enough to supply from five hundred to a thousand eighty acre farms. The water is supplied to the farmers in fixed quantities, measured either by the miner's inch or the cubic foot, being the volume of water that will flow through an inch or foot square orifice under a designated pressure; or else by the acre foot, being the quantity required to cover an acre to a depth of one foot. The price paid for the water varies according to the locality and the cost of the works.

When the rivers and streams carried a surplus, water was diverted with lavish prodigality, and irrigators gave scant heed to their respective rights because, so long as each had all he needed, he was satisfied. When, however, irrigated agriculture became an assured success, and the area of the irrigated farms increased, innumerable quarrels and law suits as to water rights ensued, and as, according to the author's estimate, there is only a sufficient supply of water to irrigate one-tenth of the arid West, the right to obtain this will be guarded with greater jealousy as time goes on. The laws in the different States as to these rights vary considerably, and are set out with much detail by the author. This, together with the practical information given as to irrigation, will render this book of very great service to those engaged either as settlers on the irrigated lands or to hydraulic engineers engaged in laying out irrigation works.

OUR BOOK SHELF.

Algebra. Part i. By Kaliprasanna Chottoraj. Pp. vi+482. (Calcutta: The City Book Society, 1903.)

THIS book is "an elementary treatise on algebra intended for use in Indian high schools." "Each rule and each process are followed by a well-graduated and sufficiently large collection of examples." These quotations from the preface serve to characterise the book. It is intended for beginners, and includes the theory of indices, and proportion, but not quadratic equations. The book is too full of rules and processes, and the student is in danger of losing his grasp of the fundamental ideas through the bewildering number of special methods, and may be led to think that he must remember the many rules and artifices which can only be acquired by practice and experience. Thus, for instance, under the heading of the resolution of x^2+ax+b into factors, we find a first method, a second method, followed by two important hints and forty-five examples; then ax^2+bx+c is treated on the same lines and at the same length.

The explanations of fundamental principles are sound and clear, and seem designed to meet every conceivable difficulty, but there is a tendency to lay stress on unessential features and mere details of presentation. As an instance of exactness, it is shown how the lowest common multiple need not be the least in an arithmetical sense. We are glad to see a whole page devoted to the distinction between an equation and an identity.

An attempt is made to define the order of the operations in an expression such as $a \div b \times c$. This can only lead to confusion and mistake. The use of brackets should be taught from the beginning.

The book is poorly printed, but of a convenient size, and will doubtless prove useful to those for whom it is intended. R. W. H. T. H.

Practical Chemistry and Physics. By J. Young, A.R.C.S., F.C.S. Pp. 108. (Woolwich: Cattermole, 1903.)

THE space allotted to "physics" is so very limited (9 pages out of 108) that the book may be considered as one on practical chemistry.

As a laboratory guide to chemical analysis there is little to distinguish it from many others dealing with the same subject. The individual reactions for the metals and acids are followed by analytical tables and a few exercises in gravimetric and volumetric analysis. A page is usefully devoted to the detection of impurities in common reagents.

The utility of a book of this kind depends in the first place on the student's previous training in practical chemistry, for it would be out of the question to put a beginner through a course which deals almost exclusively with inorganic analysis; in the second place, it depends on the amount of supervision exercised by the demonstrator, for there are neither drawings of apparatus nor details of manipulation. Granted the necessary training and supervision, one is nevertheless led to suspect from observations dropped here and there that it is not a quickening spirit of philosophic inquiry which pervades the book, but the heavy atmosphere of the examination room. "The test is too delicate for ordinary use." "Be careful always to add excess of the group reagent. Any less is quite useless; the ppt. not only fails to come, but afterwards appears in the wrong place, besides giving rise to other complications." "When the number of bases known to be present has been found, the analysis can be stopped."

A reminiscence of the old stock question of the